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Prostate Cancer Survival in the United States by Race and Stage (2001–2009): Findings From the CONCORD-2 Study

C. Brooke Steele, DO[1], **Jun Li, MD, PhD**[1], **Bin Huang, DrPH, MS**[2], and **Hannah K. Weir, PhD**[1]

[1]Division of Cancer Prevention and Control, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, Georgia

[2]Markey Cancer Center, Kentucky Cancer Registry, and College of Public Health, University of Kentucky, Lexington, Kentucky

Abstract

BACKGROUND—The 5-year relative survival for prostate cancers diagnosed between 1990 and 1994 in the United States was very high (92%); however, survival in black males was 7% lower compared with white males. The authors updated these findings and examined survival by stage and race.

METHODS—The authors used data from the CONCORD-2 study for males (ages 15–99 years) who were diagnosed with prostate cancer in 37 states, covering 80% of the US population. Survival was adjusted for background mortality (net survival) using state-specific and race-specific life tables and was age-standardized. Data were presented for 2001 through 2003 and 2004 through 2009 to account for changes in collecting SEER Summary Stage 2000.

RESULTS—Among the 1,527,602 prostate cancers diagnosed between 2001 and 2009, the proportion of localized cases increased from 73% to 77% in black males and from 77% to 79% in white males. Although the proportion of distant-stage cases was higher among black males than among white males, they represented less than 6% of cases in both groups between 2004 and 2009. Net survival exceeded 99% for localized stage between 2004 and 2009 in both racial groups. Overall, and in most states, 5-year net survival exceeded 95%.

Corresponding author: Brooke Steele, DO, Comprehensive Cancer Control Branch, Division of Cancer Prevention and Control, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Building 107, F-76, 4770 Buford Highway NE, Atlanta, GA; bsteele1@cdc.gov.

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CONFLICT OF INTEREST DISCLOSURES

The authors made no disclosures.

AUTHOR CONTRIBUTIONS

C. Brooke Steele: Writing–original draft, and supervision. **Jun Li:** Writing–review and editing. **Bin Huang:** Writing–review and editing. **Hannah K. Weir:** Conceptualization, methodology, writing–review and editing, visualization.

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CONCLUSIONS—Prostate cancer survival has increased since the first CONCORD study, and the racial gap has narrowed. Earlier detection of localized cancers likely contributed to this finding. However, racial disparities also were observed in overall survival. To help understand which factors might contribute to the persistence of this disparity, states could use local data to explore sociodemographic characteristics, such as survivors' health insurance status, health literacy, treatment decision-making processes, and treatment preferences.

Keywords

cancer registries; early detection of cancer; population-based survival; prevention and control; prostate cancer; Surveillance; Epidemiology; and End Results (SEER) summary stage; therapeutics; trends

INTRODUCTION

Prostate cancer is the second most commonly diagnosed cancer in males worldwide and, in the United States, the most commonly diagnosed invasive cancer in males.[1,2] Prostate cancer is also the fifth leading cancer-related cause of death worldwide and, in the United States, the second leading cause of cancer death among males.[1–3] In the United States, black males have higher incidence and death rates than white males.[2,3] Worldwide, black males have higher prostate cancer incidence and death rates than other males.[1] In the United States, the incidence of prostate cancer increased rapidly in the early1990s after widespread adoption of prostate cancer screening using the prostate-specific antigen (PSA) test, peaked in the early 1990s, and then declined sharply thereafter; the decline has been more gradual since 2000.[4–6] Prostate cancer death rates increased through the early 1990s and have been gradually declining since the mid-1990s among both white and black males.[6]

The first CONCORD study provided a systematic comparison of survival for males (ages 15–99 years) who were diagnosed with prostate cancer in 31 countries between 1990 and 1994 and were followed until 1999.[7] Data for the United States were included from 21 state-wide and metropolitan-area cancer registries covering 42% of the US population. International differences in age-standardized prostate cancer survival were wide, even after adjustment for differences in mortality from other causes of death, with prostate cancer survival highest in the United States compared with other countries. Five-year survival was higher for white males (92.4%) compared with black males (85.8%) in the United States. This may reflect disparities in the receipt of standard care as well as differences in stage at diagnosis.

The second CONCORD study (CONCORD-2) was undertaken, in part, to update findings from the first CONCORD study and to allow for a more in-depth examination of cancer survival by race and stage.[8] For the current study, we used CONCORD-2 data to examine cross-state trends in prostate cancer survival up to 5 years among black and white males by cancer stage.

MATERIALS AND METHODS

Data Source

We used data from 37 state-wide cancer registries that participated in the CONCORD-2 study[8] and consented to the inclusion of their data in the more detailed analyses reported here. We analyzed individual tumor records for males (ages 15–99 years) who were diagnosed with prostate cancer between 2001 and 2009 and were followed through December 31, 2009. Cases were identified using *International Classification of Diseases for Oncology* third edition topography code C61.9 (prostate) and behavior code 3 (malignant).[9] We included all cases of cancer originating in the prostate, regardless of a previous cancer diagnosis in the same individual.

Males were grouped by diagnosis year into 2 calendar periods (2001–2003 and 2004–2009) to reflect changes in the methods used by US cancer registries to collect data on stage at diagnosis. Between 2001 and 2003, most registries coded stage directly from medical records to the Surveillance, Epidemiology, and End Results (SEER) Summary Stage 2000 (SS2000).[10] Since 2004, all registries have derived SS2000 using the Collaborative Staging System.[11]

Survival Analyses

We estimated net survival up to 5 years after diagnosis and 95% confidence intervals (CIs) using the Pohar Perme estimator.[12] Net survival is the probability of survival up to a given time since diagnosis, after controlling for other causes of death (background mortality). To control for wide differences in background mortality among participating states, we used a flexible Poisson model to construct life tables of all-cause mortality in the general population of each state from the number of deaths and the population, by single year of age, sex, calendar year, and, where possible, by race (all, black, white).[13] Methods for constructing life tables have been published.[14]

We estimated net survival using the cohort approach for patients diagnosed between 2001 and 2003, because all patients had been followed for at least 5 years by December 31, 2009. We used the complete approach to estimate net survival for patients diagnosed between 2004 and 2009, because 5 years of follow-up data were not available for all patients. We obtained age-standardized survival estimates using International Cancer Survival Standard weights.[15] Unstandardized estimates are italicized in the supporting tables. Trends, geographic variations, and differences in age-standardized survival by race are presented graphically in bar charts and funnel plots.[16] The funnel plots provide insight into the variability of cancer survival in the United States by race and state and illustrate how much a particular survival estimate deviates from the pooled estimate of US registries, given the precision of each estimate. For additional details on the methods and data quality for this study, see the article by Allemani et al in this Supplement.[8]

RESULTS

In total, 1,527,602 males with prostate cancer were eligible for analysis, of whom 81.3% were white, and 13.7% were black. The pooled results from the 37 US registries are

provided in Tables (1 and 2), and 3; and state-specific results are reported in Supporting Tables 1, 2, and 3. Table 1 details the distribution of SS2000 by race and calendar period.

In the pooled estimate, the distributions of males diagnosed with localized, regional, and distant prostate cancer were similar during both calendar periods. Between the periods from 2001 to 2003 and from 2004 to 2009, the proportions of cases diagnosed at localized stage increased from 72.8% to 76.8% among black males and from 77.2% to 78.8% among white males. More black males than white males were diagnosed with distant stage prostate cancer between 2001 and 2003 (5.7% vs 3.5%) and between 2004 and 2009 (5.2% vs 3.5%). Similar patterns in the distribution of stage by race were observed in the states during both calendar periods (Supporting Table 1).

Table 2 presents 1-year, 3-year, and 5-year survival estimates by race and calendar period. Overall, survival did not change between the 2 calendar periods. Net survival estimates among males who were diagnosed between 2001 and 2003 were 98.6% at 1 year, 97.4% at 3 years, and 96.7% at 5 years; corresponding estimates among males who were diagnosed between 2004 and 2009 were 98.8%, 97.6%, and 96.9%, respectively. White males had higher 1-year, 3-year, and 5-year net survival than black males. This pattern held true in most states (Supporting Table 2).

Table 3 displays 5-year net survival estimates by race and stage. The pooled estimates for the US registries were comparable between black and white males for localized, regional, and distant prostate cancer during both calendar periods. Between 2004 and 2009, survival exceeded 99% for localized stage and less than 29% for distant stage in both racial groups. However, corresponding estimates varied across the states (Supporting Table 3).

During both calendar periods, as illustrated in Figure 1, the age standardized, 5-year net survival estimates across most states were very high (≥95%) for all races combined. State-specific differences in 5-year net survival were small between males diagnosed between 2001 and 2003 and those diagnosed between 2004 and 2009. Racial and geographic differences in 5-year net survival are displayed graphically in funnel plots (Fig. 2). Survival among black males (Fig. 2, solid circles) was lower compared with that among white males (Fig. 2, open circles), and most estimates were below the pooled estimate. There was less variation around the pooled estimates among white males.

DISCUSSION

This study compared prostate cancer stage distribution and survival estimates by race among males who were diagnosed between 2001 and 2003 and between 2004 and 2009 in 37 states, covering 80% of the US population. We observed high percentages of localized prostate cancer among black and white males diagnosed during both calendar periods, whereas black males had slightly higher proportions of distant disease at diagnosis compared with white males. Overall, there was no change in net survival between the 2 calendar periods in either racial group. The high but stable survival estimates in our analysis might reflect trends in prostate cancer incidence, rather than true improvements in survival. The incidence of prostate cancer increased rapidly between the 1980s and the 1990s, largely because of the

widespread use of PSA-based screening.[17] The increase in incidence was followed by a steady decline in the late 1990s, as the pool of prevalent cases available for detection decreased.[18–20] It has been reported that the declines in incidence of localized/regional prostate cancer and of distant prostate cancer started in 2001 and 1995, respectively.[17] Another study noted that most decreases in prostate cancer incidence since 2008 have occurred uniformly across age and racial/ethnic groups among males diagnosed at the localized/regional stage.[20] Similar to prostate cancer incidence, prostate cancer mortality rates started to decrease in the 1990s.[3,18,21–23] The decline has been attributed to several different factors, including PSA screening intensity and improvements in treatment of distant-stage disease.[18,21–23]

Five-year net survival among black and white males who were diagnosed with localized/regional prostate cancer between 2001 and 2009 approached 99% overall and in most states. Previous studies have reported that racial disparities in prostate cancer survival among males diagnosed at these stages have decreased over time.[24–26] During both calendar periods, we observed that 5-year net survival for all other stages was also comparable among black and white males. Across the states, there was more variation in survival among males diagnosed at distant stage than among those diagnosed at other stages; however, these estimates were based on small numbers. State-specific variation in cancer survival might be related to differences in the demographic characteristics of males at risk for prostate cancer, in spending on cancer prevention and control, and in health insurance coverage rates.[27–29]

The very high 5-year prostate cancer survival that we observed among US males has also been reported among males in several European countries.[8] Survival increased in many of these countries between the periods from 1995 to 1999 and from 2005 to 2009; however, increases were smaller in North America, where survival has been very high since the early 1990s.

Clinical Implications

Although adoption of PSA-based prostate cancer screening in the United States over the past 2 decades has led to diagnosis of prostate cancer at earlier stages and improved survival, it has also resulted in overdiagnosis (ie, detection in individuals who would have died of other causes) and over-treatment of many clinically insignificant tumors.[30,31] Therefore, as concerns about potential harms of PSA-based screening emerged, some organizations and professional societies recommended against screening males of all ages; however, others emphasized shared decision making and age-specific testing.[32–37] Strategies to help clinicians reduce these problems have included updating prostate cancer screening recommendations and using prediction tools to help improve risk stratification.[38–40] Tools in use or development to improve clinical stratification for screening and treatment include biomarkers, nomograms, genomic testing, and enhanced imaging.[39,40] Increased use of active surveillance for males diagnosed with localized prostate cancer might also relieve some of the burdens associated with early intervention.[38]

Findings regarding the effect of widespread PSA screening on prostate cancer mortality have been mixed. Some studies have reported that testing reduces the number of deaths from the disease, but others did not report an association.[21,41–43] The age-adjusted annual death rate

from prostate cancer among black males is 2 to 3 times that of white males, which is caused in part by their higher disease incidence, tumor characteristics, treatment choices, and socioeconomic status.[2,44] Deaths have been declining since 1996 at a rate of 3.6% per year among black males and 3.4% among white males.[26] However, the reasons for the persistence of the racial disparity are not clear.

Changes in clinical management of prostate cancer in the United States over the past 3 decades also may have affected survival. A dramatic increase in the receipt of radical prostatectomy overall was reported from the mid-1980s, followed by a plateau in the early 1990s; the rate started to increase again in the early 2000s, but the increase was gradual.[21] Among males with small, low-grade, clinical stage T3 (ie, locally advanced) prostate cancer, an increase in the receipt of surgery was reported between 1998 and 2012.[45] One study reported that surgery receipt declined between 1995 and 2013 among males with low-risk prostate cancer, whereas it increased among those with intermediate-risk prostate cancer and among older males with low-risk and intermediate-risk disease.[46] In another study, however, receipt of radical prostatectomy increased between 2004 and 2010 among males with low-risk and intermediate-risk prostate cancer.[47]

Demographic disparities have been reported in the receipt of definitive treatment for prostate cancer, with lower rates among black males and variations by insurance type, geographic region, and age group.[29,48–55] Differences in treatment preferences may account for some of these disparities. In earlier research examining treatment choice among males with localized prostate cancer, black males reportedly were more likely to select nonsurgical options compared with their white counterparts.[49,56,57] A more recent study indicated that, although active surveillance was the most preferred treatment among black and white males with localized prostate cancer, surgery was more common among black males.[58] The treatment decision-making process also may differ by race/ethnicity and by other sociodemographic factors. In 1 study of males with localized prostate cancer, white males selected active surveillance/watchful waiting based on cancer risk, but black males did not; this raises concerns about under-treatment and lack of understanding about cancer risk among the latter group.[53] A study of treatment choice among males in urban and rural parts of Georgia reported that disparities may be related more to differences in income than differences in race.[55] The authors also noted, however, that poor communication with physicians was more prevalent among black patients and was associated with not receiving treatment in rural areas.

Cancer-Control Implications

Monitoring disparities in prostate cancer survival, especially with survival rates for distant stage, requires high-quality surveillance data. To more comprehensively define these disparities, the data could be enhanced with information about socioeconomic factors and other social determinants of health that affect cancer outcomes.[59] Lack of insurance, low educational attainment, and poverty status are all associated with increased cancer risk and poor outcomes.[25,27,29,50] To help assess prostate cancer outcomes across the states, cancer-control practitioners could continue to work with programs like the Centers for Disease Control and Prevention's (CDC's) National Program of Cancer Registries (NPCR) and

National Comprehensive Cancer Control Program.[60] Other CDC resources available to cancer-control planners include communication materials that explore clinician-patient discussions about prostate cancer screening and treatment, research that has examined enhancement of prostate cancer data in cancer registries and patterns of prostate cancer care, and findings from an active surveillance state-of-science consensus conference organized by the agency. In addition, the CDC has supported projects to explore patient information-seeking behavior postdiagnosis, caregiver and provider involvement in treatment decision making, and patient quality of life after prostate cancer treatment.[61] To help reduce disparities in receipt of prostate cancer treatment, cancer-control planners could examine these factors and others, such as patient comorbidities and provider characteristics. They also might assess whether disparities in post-treatment care affect long-term and late effects that prostate cancer survivors may experience.

The current study has notable strengths. The CONCORD-2 study is the largest comparative study of population-based cancer survival in the United States, and it includes high-quality data covering 80% of the US population. Standardized collection, reporting, and analysis of the data ensures the availability of comparable data. A high percentage (>97%) of cases in the United States are microscopically confirmed, and the percentage of cases with unknown stage (11.1% in 2001–2003, 8.4% in 2004–2009) is relatively low.[8]

However, this study has a few limitations, which might influence interpretation of the results. First, follow-up procedures among cancer registries in the United States differ, depending on federal funding source.[60] All SEER registries are required to conduct active follow-up of all registered cases to ascertain vital status. NPCR registries are only funded to ascertain deaths through linkages with state vital records and the National Death Index; therefore, they may overestimate survival time and miss some deaths, because death ascertainment is conducted primarily through data linkages.[62] Second, the manner in which SS2000 data were collected and reported changed for all registries in 2004, as described above (see Materials and Methods). The impact of this change was most evident in NPCR-funded registries, where the percentage of cases with unknown stage decreased somewhat when stage was derived rather than manually coded.

Conclusions

Prostate cancer survival remains high among males whose disease is detected early, and the racial gap in survival observed in the first CONCORD study has narrowed. Disparities in receipt of standard and timely care are still being reported, however, particularly among males who might benefit most from treatment.[48–52,54] To help ensure that all prostate cancer survivors receive appropriate care, cancer-control planners could optimize their use of local data and resources to explore demographic differences in survivors' access to health insurance, primary and specialty medical care, and timely receipt of treatment. Clinicians should be aware that, although a recent study of males diagnosed with low-risk prostate cancer indicated that most patients were satisfied with their treatment decision-making discussions with physicians, a patient's health literacy could affect his understanding of cancer risk and treatment options.[58]

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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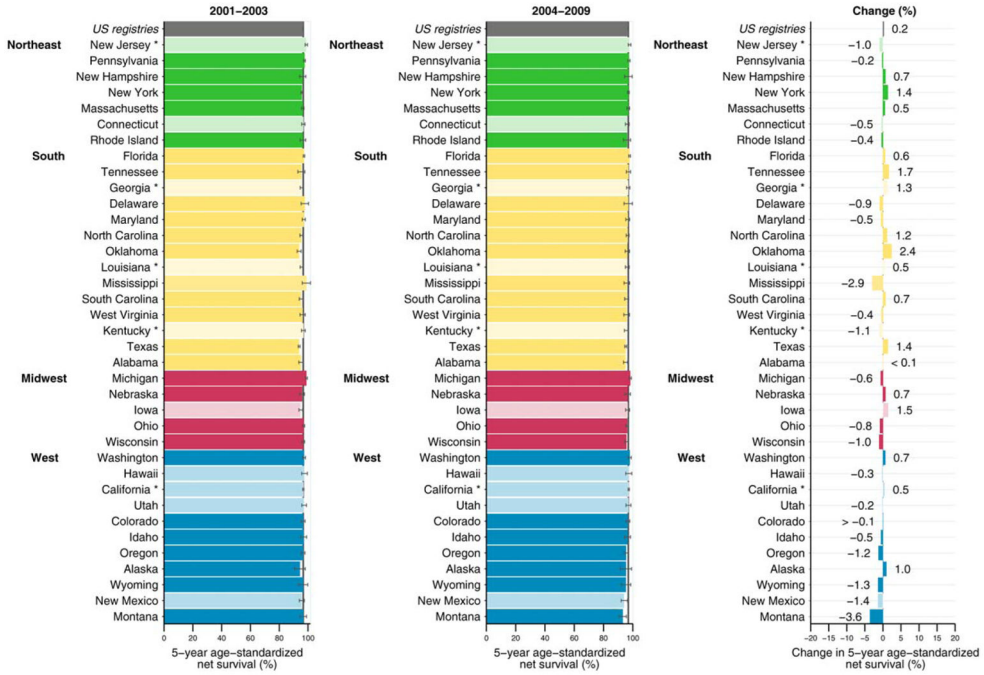

Figure 1.

Prostate cancer 5-year, age-standardized net survival (%) for males (ages 15–99 years) diagnosed between 2001 and 2003 and between 2004 and 2009 and absolute change (%) are illustrated. States are grouped by US Census region. Note that data from 37 statewide cancer registries (covering 80.6% of the population) are ranked within US Census Region by the survival estimate for 2004 to 2009. Dark colors denote states affiliated with the National Program of Cancer Registries (NPCR), and pale colors denote states affiliated with the Surveillance, Epidemiology, and End Results (SEER) Program. An asterisk denotes states affiliated with both federal surveillance programs. Change (%) was not plotted if a survival estimate was not available for 1 calendar period or if 1 or more estimates were not age-standardized.

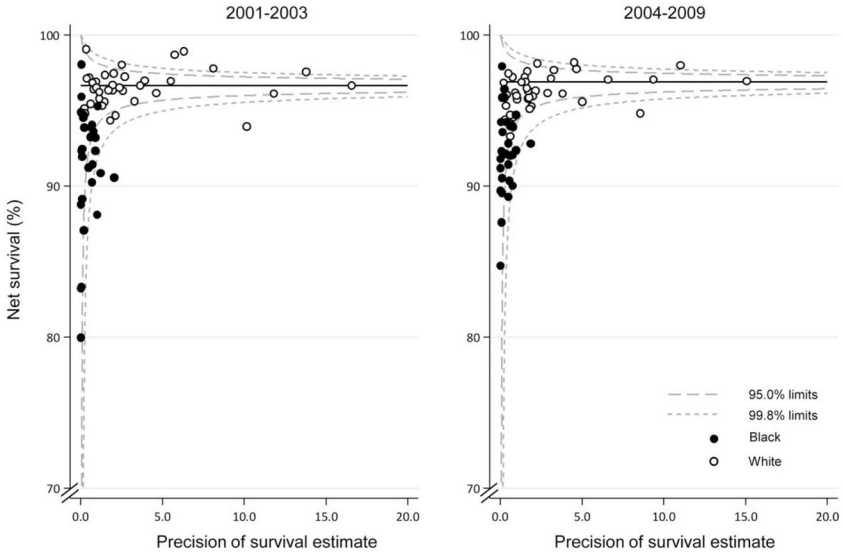

Figure 2.

Prostate cancer 5-year, age-standardized net survival (%) is illustrated for males (ages 15–99 years) by state, race, and calendar period of diagnosis. Note that the pooled US survival estimate for each calendar period is indicated by the horizontal (solid) line with corresponding 95.0% and 99.8% control limits (dashed lines).

TABLE 1

Prostate Cancer: Number of Males (Ages 15–99 Years) Diagnosed Between 2001 and 2009 and Distribution (%) by Surveillance, Epidemiology, and End Results Summary Stage 2000 at Diagnosis by Race and Calendar Period of Diagnosis

	2001–2003			2004–2009		
SEER Summary Stage 2000	**All Races**	**White**	**Black**	**All Races**	**White**	**Black**
No. of patients	494,511	410,029	64,335	1,033,091	831,576	144,561
Localized, %	76.5	77.2	72.8	78.2	78.8	76.8
Regional, %	8.7	8.8	8.3	9.6	10.0	8.3
Distant, %	3.7	3.5	5.7	3.7	3.5	5.2
Unknown, %	11.1	10.6	13.3	8.4	7.6	9.6

Abbreviations: SEER, Surveillance, Epidemiology, and End Results program.

TABLE 2

Prostate Cancer: Age-Standardized Net Survival (%) at 1, 3, and 5 Years for Males (Ages 15–99 Years) Diagnosed Between 2001 and 2009 by Race and Calendar Period of Diagnosis

	2001–2003						2004–2009					
	All Races		White		Black		All Races		White		Black	
Years	NS (%)	95% CI	NS (%)	95% CI	NS (%)	95% CI	NS (%)	95% CI	NS (%)	95% CI	NS (%)	95% CI
1	**98.6**	98.5–98.7	**98.7**	98.7–98.8	**96.8**	96.6–97.1	**98.8**	98.8–98.9	**98.8**	98.8–98.9	**97.3**	97.1–97.5
3	**97.4**	97.3–97.5	**97.6**	97.5–97.8	**94.2**	93.8–94.6	**97.6**	97.6–97.7	**97.6**	97.5–97.7	**94.7**	94.4–95.1
5	**96.7**	96.5–96.8	**96.9**	96.7–97.1	**92.4**	91.8–92.9	**96.9**	96.7–97.1	**96.9**	96.7–97.1	**92.7**	92.1–93.3

Abbreviations: CI, confidence interval; NS, net survival.

TABLE 3

Prostate Cancer: Five-Year, Age-Standardized Net Survival (%) for Males (Ages 15–99 Years) Diagnosed Between 2001 and 2009 by Surveillance, Epidemiology, and End Results Summary Stage 2000 at Diagnosis, Race, and Calendar Period of Diagnosis

	2001–2003						2004–2009					
	All Races		White		Black		All Races		White		Black	
SEER Summary Stage 2000	NS (%)	95% CI	NS (%)	95% CI	NS (%)	95% CI	NS (%)	95% CI	NS (%)	95% CI	NS (%)	95% CI
All stages	**96.7**	96.5–96.8	**96.9**	96.7–97.1	**92.4**	91.8–92.9	**96.9**	96.7–97.1	**96.9**	96.7–97.1	**92.7**	92.1–93.3
Localized	**99.9**	99.7–100.0	**99.8**	99.6–100.0	**99.5**	98.8–100.0	**99.9**	99.6–100.0	**99.7**	99.5–99.9	**99.6**	98.8–100.0
Regional	**93.7**	92.9–94.4	**93.4**	92.6–94.2	**90.8**	88.3–93.4	**93.5**	92.7–94.4	**93.3**	92.4–94.2	**90.7**	87.8–93.6
Distant	**29.8**	28.9–30.6	**29.7**	28.7–30.7	**28.6**	26.8–30.4	**29.2**	28.3–30.1	**28.7**	27.6–29.8	**28.4**	26.6–30.3
Unknown	**88.3**	87.8–88.7	**88.3**	87.8–88.8	**83.9**	82.7–85.2	**88.0**	87.5–88.5	**87.3**	86.7–87.9	**82.2**	80.7–83.7

Abbreviations: CI, confidence interval; NS, net survival; SEER, Surveillance, Epidemiology, and End Results program.